GR 98 P 2544

# PRINTED CIRCUIT BOARD CONFIGURATION WITH A MULTIPOLE PLUG-IN CONNECTOR

## Cross-Reference to Related Application:

This application is a continuation of copending International Application No. PCT/DE99/02785, filed September 2, 1999, which designated the United States.

## Background of the Invention:

### Field of the Invention:

The invention relates to a printed circuit board configuration with a multipole plug-in connector.

The invention is directed toward shielding an electronic assembly from radio-frequency electromagnetic radiation generated outside the electronic assembly, such as e.g., radio-frequency interference from transmitters or interference caused by ignition and discharge operations. The invention is also directed toward reducing the radio-frequency emission from the assembly itself, such as e.g. radio-frequency interference current on the supply lines caused by microcontrollers in the assembly. While the entire circuit configuration can be shielded relatively simply by a metal housing, the circuit connections penetrating through the

housing represent particular problem zones in this case. The bushings of the connections can be designed in a way to provide the best possible shielding through the realization of so-called filter plug-in connectors, as described for example in the technical paper "Filter-Steckverbinder für die elektromagnetische Entstörung" [Filter plug-in connectors for electromagnetic interference suppression] by Matthias Weber and Hans-Peter Mayr (ATZ Automobiltechnische Zeitschrift 91 (1989), pages 588 to 591). This plug-in connector is designed as a planar low-pass filter using thick-film technology and has signal and ground electrodes which are isolated from one another by a dielectric layer and which overlap one another. In this respect, the filter plug-in connector in accordance with the aforementioned technical paper is constructed in a relatively complex manner.

European Patent EP 0 563 071 B1 describes a radio-frequency-shielding housing of a circuit, e.g. for the control circuit of an airbag of a vehicle, in which the bushing of the plug pins is effected via an anterior space which is isolated and shielded from the rest of the housing.

International Publication WO 95/33291 A1 discloses a surface-mounted plug-in connector in which the plug pins are soldered by their offset board-pertaining ends in a planar manner on the corresponding conductor tracks of the board.

Finally, it is customary in the relevant technical field, for the purpose of shielding radio-frequency interference, to place capacitors between the input and output signal conductor tracks and corresponding ground conductor tracks of a printed circuit board configuration. In this case - as can also be seen, for example, in European Patent EP 0 563 071 B1, already mentioned - the plug pins can run together perpendicularly to the board and can be soldered with a signal conductor track and corresponding contact holes. One connecting pole of the respective capacitors is connected to these signal conductor tracks, and the other connecting pole is located on a common ground track lying parallel before the plug. The emplacement of the capacitors and the shielding effect that can be achieved are problematic in this configuration.

Japanese Patent Document JP 8-306410 A discloses arranging plate-like conductor ends on an end surface of parallel striplines. Only part of the conductor end projects from a dielectric which embeds a section of the conductor end.

Japanese Patent Document JP 9-46006 A discloses a configuration having parallel microstrip conductors between which a ground line is configured. The conductors are configured on a dielectric provided with a ground layer. The ground line is connected to the ground layer.

Published German Patent Application DE 44 00 160 A1 relates to a printed circuit board for a bus system with a multiplicity of connection points for lines which are to be coupled to the bus. One conductor surface is designed as a ground surface which is connected to no other potential of the system. The connection points are provided with filter capacitors.

Japanese Patent Document JP 1-138786 A discloses an integrated circuit having a shielding layer which surrounds the signal-carrying conductors three-dimensionally.

International Publication WO 98/06243 discloses a method for producing shielded conductor tracks on printed circuit boards. The printed circuit board comprises a flexible printed circuit board which is covered on both sides with dielectric bonding sheets. The bonding sheets each have a copper layer. A signal conductor running parallel between two shielding conductors is configured on the flexible printed circuit board.

Published German Patent Application DE 44 25 803 A1 relates to a printed circuit board with cost-effective current parts which can be subjected to high loading. For this purpose, a conductor track is strengthened with a soldered-on metal strip. Such a metal strip can project over the edge of the

printed circuit board in order to be used as a conventional flat plug-in prong.

Summary of the Invention:

It is accordingly an object of the invention to provide a printed circuit board configuration which overcomes the above-mentioned disadvantageous of the prior art apparatus of this general type. In particular, it is an object of the invention to provide a printed circuit board configuration with a structurally simple and compactly configured multipole plug-in connector having a good shielding effect.

With the foregoing and other objects in view there is provided, in accordance with the invention, a printed circuit board configuration with a multipole plug-in connector. The configuration includes a board having at least two layers. Each one of the at least two layers has an edge region. A plurality of signal conductor tracks are disposed in the edge region of one of the layers. A plurality of plug pins is provided. Each one of the plurality of the plug pins is fixed to a respective one of the plurality of the signal conductor tracks in a direction parallel to the one of the layers. A plurality of ground conductor tracks is disposed on the one of the layers and is assigned to the plurality of the signal conductor tracks. A side-to-side configuration is provided in which the plurality of the signal conductor tracks and the

plurality of the ground conductor tracks are alternatingly disposed on the one of the layers, and in which the plurality of the signal conductor tracks run essentially parallel with respect to the plurality of the ground conductor tracks. At least one filter capacitor is connected between a respective one of the plurality of the signal conductor tracks and a respective one of the plurality of the ground conductor tracks. A ground shielding surface is disposed on an adjacent one of the layers and covers the side-to-side configuration.

Thus, by virtue of the fact that the plug pins are fixed on respective signal conductor tracks and parallel to a board layer, the plug-in connector does not take up appreciable space in the height direction with respect to the board, which provides a compact configuration. The alternate side-to-side configuration of the signal and ground conductor tracks on the board layer and the additionally provided ground shielding surface on an adjacent board layer provide for a good shielding effect. In this case, it is advantageous that all of the conductor tracks as well as the ground shielding surface can be provided using customary production technology for the application of conductor tracks to boards, that is to say with no additional production outlay. Overall, all of the components in the plug area can be placed optimally, which in practice may lead to an improvement of the so-called electromagnetic compatibility with regard to irradiation and

radiation emission by more than 20 dB. Furthermore, the shielding chamber provided in the prior art - e.g. the anterior space for bushing the plug pins which is described in European Patent EP 0 563 071 B1 - can be completely omitted.

In accordance with an added feature of the invention, the board is formed with a plurality of plated through-holes therein, and the plurality of the plated through-holes electrically connect the plurality of the ground conductor tracks to the ground shielding surface.

In accordance with an additional feature of the invention, each one of the plurality of the ground conductor tracks is electrically connected to the ground shielding surface by more than one of the plurality of the plated-through holes.

In accordance with another feature of the invention, the at least one filter capacitor is one of a plurality of filter capacitors. Each one of the plurality of the filter capacitors is connected between a respective one of the plurality of the signal conductor tracks and a respective one of the plurality of the ground conductor tracks at a location that is remote from the plurality of the plug pins.

In accordance with a further feature of the invention, there is provided, a shielding plate covering the side-to-side

configuration. The side-to-side configuration defines a first surface adjacent the ground shielding surface and defines a second surface that is opposite the first surface and that is adjacent the shielding plate.

In accordance with a further added feature of the invention, the plurality of the ground conductor tracks includes two outer ground conductor tracks, and the shielding plate is fixed on and is electrically connected to the two outer ground conductor tracks.

In accordance with a concomitant feature of the invention, the one of the layers defines a first outer board layer, the another one of the layers defines an inner board layer, the at least two layers includes a second outer board layer remote from the first outer board layer, and a similar configuration of signal conductor tracks, plug pins and ground conductor tracks is configured in or on the second outer board layer.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described herein as embodied in a printed circuit board configuration with a multipole plug-in connector, it is nevertheless not intended to be limited to the details shown, since various

modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

Brief Description of the Drawings:

Fig. 1 shows a schematic partial plan view of a printed circuit board configuration with a multipole plug-in connector; and

Fig. 2 shows a section through the configuration shown in Fig. 1 that is taken along the section line II-II.

Description of the Preferred Embodiments:

Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof, there is shown a portion of a two-layer board 1 having a substrate made of PCB material. The figure details an area of the printed circuit board 1 involving a multipole plug-in connector 2. A board layer 3 is positioned at the top of the board 1. Three signal conductor tracks 4.1, 4.2, 4.3 are guided parallel at a

distance from one another and orthogonally meet the edge 5 of the board 1. Ground conductor tracks 6.1, 6.2, 6.3, 6.4 are configured alternately with the signal conductor tracks 4.1, 4.2, and 4.3 in a side-to-side fashion and in parallel with the conductor tracks 4.1, 4.2, and 4.3. The ground conductor track 6.2 is configured between the signal conductor tracks 4.1 and 4.2, and the ground conductor track 6.3 is configured between the signal conductor tracks 4.2 and 4.3. Ground conductor tracks 6.1 and 6.4 are configured next to the outer signal conductor tracks 4.1 and 4.3, respectively. The ground conductor tracks 6.1, 6.2, 6.3, 6.4 end at a distance 7 from the edge 5 of the board 1.

Plug pins 8.1, 8.2, 8.3 are on the board layer 3 and bear flat and parallel with the signal conductor tracks 4.1, 4.2, 4.3. The plug pins 8.1, 8.2, 8.3 are soldered in a planar manner on the signal conductor tracks 4.1, 4.2, 4.3 for the purpose of making electrical contact. In this case, the ends 9 of the plug pins 8.1, 8.2, 8.3, which project beyond the edge 5, are provided for plugging into a corresponding socket configuration.

Referring now to Fig. 2, a ground shielding surface 11 is provided on the bottom board layer 10, which is remote from the top board layer 3. The ground shielding surface 11 covers the surface region occupied by the signal conductor tracks

4.1, 4.2, 4.3 and the ground conductor tracks 6.1, 6.2, 6.3 and 6.4. This becomes clear from the contour 12 of the ground shielding surface 11 shown by dash-dotted lines in Fig. 1. The ground shielding surface 11 is electrically connected to each ground conductor track 6.1, 6.2, 6.3 and 6.4 a number of times via plated-through holes 13 running through the board 1. The ground shielding surface 11 can also be realized on an inner layer in the case of multilayer boards.

As is only illustrated in figure 1, for the sake of clarity, a filter capacitor 14 is connected between the signal conductor track 4.1 and the ground conductor track 6.1 on the side or end of the plug-in connector 2 which is remote from the plug pin 8.1. Such filter capacitors are connected 14 between corresponding signal/ground conductor track pairs at the end of the ground conductor tracks 6.1, 6.2, 6.3 and 6.4 build up low-impedance parasitic capacitances. These parasitic capacitances act right into the honed frequency range between the signal conductor tracks 4.1, 4.2, and 4.3 and the ground conductor tracks 6.1, 6.2, 6.3 and 6.4. The coupling paths for radio-frequency interference are thus principally restricted to the plug-in connector 2 in the region between the signal conductor tracks 4.1, 4.2, and 4.3 and the ground regions in between and underneath the signal conductor tracks 4.1, 4.2, and 4.3. These ground regions are in the form of the ground

conductor tracks 6.1, 6.2, 6.3 and 6.4 and the ground shielding surface 11.

Finally, in order to improve the shielding properties, it is also possible to provide a further shielding plate 15, indicated by dashed lines in the drawings, which straddles the signal conductor tracks 4.1, 4.2, 4.3 in the region of the plug-in connector 2. The further shielding plate 15 is fixed on the two outer ground conductor tracks 6.1, 6.4 and is electrically connected thereto.

It should be pointed out that in the case of multilayer boards, corresponding signal conductor tracks and ground conductor tracks can be configured on the respective outer board layers 3, 10. The ground shielding surface 11 is then situated on one or both of the inner board layers which lie adjacent to these two plug-in connector regions.